Climate Transition Center

The big shift: Navigating the interconnected complexities of the energy transition

Rakhi Kumar, Senior Vice President of Sustainability Solutions and Business Integration and Climate Council Chair
Victoria Yanco, Sustainability Consultant

Introduction

Climate change poses an interconnected set of risks to the economy from both the physical hazards driven by a warming planet and the transition to a new mix of renewable energy sources. The concepts of climate change and energy transition are intertwined and any discussion on mitigating climate change quickly becomes a conversation about the need to transition the energy sector from a reliance on fossil fuels that are high carbon emitting to more renewable or low carbon emitting sources of energy.

However, mitigating climate change requires much more than transitioning the energy sector. It is a once in a generation socio-economic transition event that requires system-level change, at a global scale, in a time frame that has never been attempted in the past. For example, it includes:

- Transitioning all sectors of the economy to consume less energy overall
- Leveraging circular economic thinking in the design, manufacturing and operational process to support the transition from a high emissions to a low emissions powered economy
- Changing human/ customer behavior to create fewer emissions and demand different types of products and services

Yet, the current approach to evaluating progress against climate change is overly focused on measuring and mitigating portfolio-specific emissions. Evolving research is starting to question an emissions reduction portfolio focused approach to transition given that some high emitting activities[1] such as mining for lithium are enabling activities, which support the transition to a lower carbon economy. Demand for these activities will continue to grow and are critical to achieving the transition to a low carbon economy.[2]

We believe that the complexity of the upcoming transition requires a systems-level approach – one that seeks to understand the scientific, social, economic and technological trends embedded in climate models. Systems thinking involves recognizing interconnections, understanding feedback loops and dynamic behavior, and recognizing the structure and scale of systems and events that are related.[3] By studying these macro insights we can understand the different climate transition pathways suggested by these climate models that can then be integrated into business strategy.

In this paper we leverage insights from Liberty Mutual's climate scenario transition research, which is based on research from the Network for Greening the Financial System (NGFS)[4] to answer the following questions:

- What do we mean by the term "energy transition"?
- What are the demand and supply drivers that need to be part of the energy transition discussion for a successful and smoother transition to a low carbon economy?
- How can we conceptualize the scope of the transition at the system level to inform a company's transition strategy?

We also share Liberty's framework to conceptualize and anticipate economic and sector de-carbonization pathways that can be leveraged by companies as they strive to understand and build realistic transition pathways to a low carbon economy.

Leveraging the Network for Greening of the Financial System (NGFS)

While many companies are turning to private sector solutions for climate scenario analysis to better understand the implications of the energy transition on their portfolios, Liberty Mutual found that the NGFS scenarios provide clear and customizable insights into what a plausible low carbon future might look like.

NGFS uses a collection of data (economic, climate, energy, agricultural) to design a set of transition scenarios in partnership with climate experts and economists. The scenarios provide reference points for understanding climate change with consideration of upcoming policy and technology trends – as well as the various ways these trends could evolve in the future. These scenarios outline a range of physical and transition risk outcomes, which helps diagnose the climate challenge that informs business strategy and develops solutions to mitigate risks and/or growth opportunities. While the insights can be leveraged, it should be noted that the NGFS scenarios constitute an evolving framework with a degree of model volatility as the policy environment and underlying scientific and economic assumptions are updated annually.

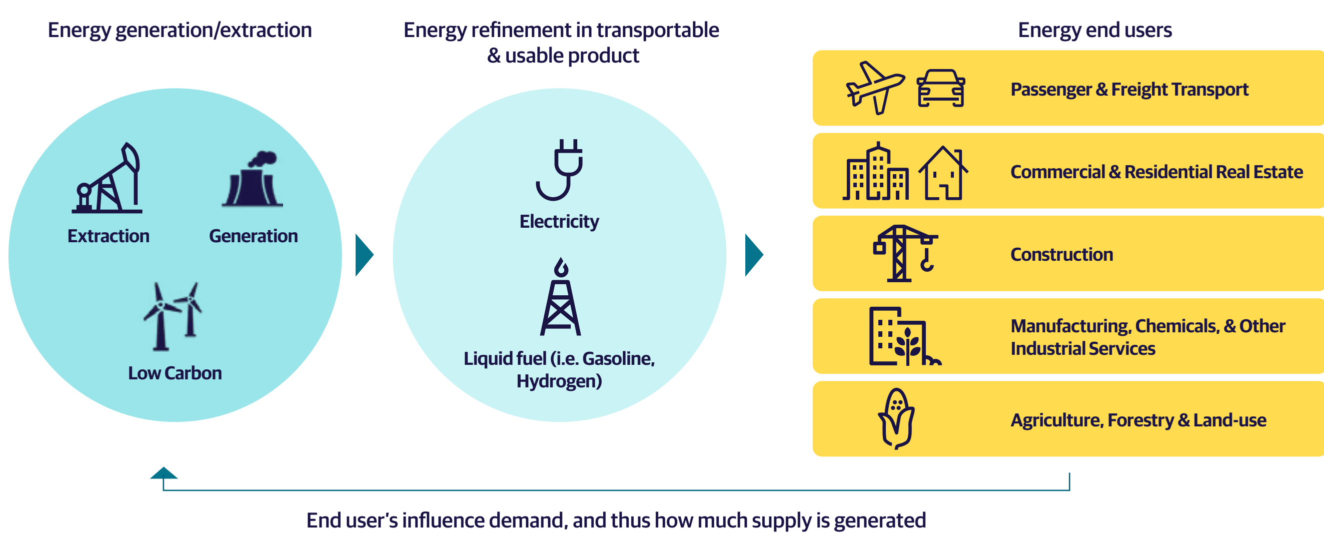
The energy transition: An opportunity for global coordination

Transitioning to a low-carbon economy is necessary to limit the most extreme future impacts of climate change. The transition will require us to not only change the energy sources that we rely upon to power society by utilizing less carbon intensive forms of energy, but also to reduce energy demanded by end users.

Exhibit 1 below shows the energy system and the different sectors that need to be involved to facilitate an energy transition. This includes businesses involved in generation, refinement, and consumers of energy – sectors such as agriculture, transportation, manufacturing, construction, and real-estate. As the graphic illustrates, there isn't a single economic sector that will not be impacted by the energy transition.

Energy system interactions: From generation to refinement to end use

Exhibit 1: Understanding the demand and supply drivers for energy to support a smoother energy transition



Often the energy transition is predominantly focused on energy suppliers - particularly the fossil fuel industry. However, end use sectors must also actively participate in the transition by innovating to reduce energy demand; in some cases, entire end-use sectors must change the way they operate and how they develop their products and infrastructure.

The transition to a low carbon economy is dependent on several factors, such as technological advancements, policy developments and behavioral changes. It is important to acknowledge and expect that the transition will look different from country to country, as each has its own set of challenges to navigate, like infrastructure capacity and need for economic growth. The combination of these challenges makes understanding the energy transition a uniquely difficult task.

It is critical for global economic stability that different sectors and countries adopt a coordinated approach to climate transition to limit economic shocks. For example, carbon price is a significant component of the Canadian climate transition policy where industries such as oil sands are helping to fund Canada's emission reduction and economic transition.[5] In the EU, the green taxonomy does not consider activities related to funding or assisting the oil sands industry as supporting the transition. A coordinated approach would require the EU to carve out an exception for Canadian oil sands given the carbon price imposed by the Canada government is part of its commitment to align with goals of the Paris Accord. Without a coordinated approach, we risk compromising energy security and creating more acute economic disruptions (or transition risks) for companies and communities down the line.

Like other historical instances of energy transitions, in the shift to low-carbon energy, regions should make a concerted effort to identify what resources they can produce domestically, and those they have to import.

As evidenced by the Ukraine-Russia war, it is also critical for energy security in a world filled with the additional stressors of a changing climate, to establish strong domestic energy production programs and create inviolable relationships for undisrupted energy transmission across borders.

Putting the scale of the energy transition into perspective

The world produces roughly 600 exajoules (EJ) of primary energy annually. Net zero goals require the world to reduce primary energy generation to around 500 EJ annually – a reduction of roughly 100 EJ in total primary energy production annually by 2050.*

For perspective 1 EJ powers roughly 26 million homes per year** or approximately 17 million cars per year.***

Reducing primary energy production by 100 EJ is the equivalent of:

- 2.5 billion homes no longer consuming any electricity or,
- Taking 1.6 billion cars off the road i.e. all the cars we have today and more.

*NGFS V2.0 GCAM model

**The average annual electricity consumption for a U.S. residential utility customer was 10, 715 kWh in 2020. Source: US Energy Information Administration (EIA)

***The average American used approximately 414 gallons of gas in 2019. Source: Green Car Congress

A framework to conceptualize the energy transition

The Task Force on Climate-related Financial Disclosures (TCFD) identifies policy, technology, and market changes as the core sources of climate transition risk.[6] We have leveraged these categories to develop a framework that allows companies to understand and identify key sources of transition risk and opportunity drivers in an economy (see Exhibit 2) that need to be considered in the transition planning process.

Exhibit 2: Liberty's framework to conceptualize economic and sector de-carbonization drivers

	Key influencers of sector de-carbonization
Policy developments	• Policy actions that attempt to **constrain actions** that contribute to the adverse effects of climate change • Policy actions that **promote adaptation** to climate change Examples: • Carbon price mechanisms • Energy efficiency policies • Shifting to low emissions energy sources The risk and financial impact is dependent on the **nature and timing** of the policy change
Technology advancements	• Technological improvements or innovations that **support the transition** to a lower-carbon economy Examples: • Renewable energy • Battery storage • Energy efficiency • Carbon capture and storage • Some new technologies will displace old systems and disrupt parts of the economic system The **timing** of technology deployment and development is a **key uncertainty**
Behavioral (market) changes	• **Shifts in supply and demand** for certain commodities or services driven by consumer preferences or changing needs Examples: • New preferences for different modes of transportation • New needs emerging from changes in supply chain, available technology, or regulatory changes Behavior change is perhaps the **most uncertain** driver of decarbobonization

Policy developments

Because of the sheer size and anticipated cost of the energy transition, market forces are not expected to work quickly enough to prevent severe climate change impacts. As such, policy changes are necessary for spurring the energy transition. Additionally, the transition to a low-carbon economy requires system-level change that individual company actions cannot address.

The pace and magnitude of policy developments will depend largely on an economy's readiness to transition from its current fossil fuel dependencies to a more balanced mix of fossil fuels and renewables. We expect that policy development will vary across the globe depending on economy-specific needs, as policymakers seek to reduce macro-economic and other transition-related stresses on their economies. For instance, it is expected that developing countries will take longer to transition because they will require more energy to spur industrialization while often lacking the institutional capacity and financing to quickly create the infrastructure necessary to support renewable energy.

The indicators that can help an energy company, and companies closely tied to them, understand and anticipate the pace and magnitude of an economy's de-carbonization policy include:

1. An economy's primary energy consumption, regardless of whether it is derived from fossil fuel or renewable sources[7]
2. An economy's independence or interdependence on other countries for energy sources and/or raw materials that are key inputs needed in renewable sources of energy or new technology
3. Current renewable energy infrastructure capacity and future investment commitments

Technology advancements

The energy sector of the future will require a more balanced mix of fossil fuels and renewables. To achieve this, technological advancements in fossil fuels and renewable sources are needed to reduce carbon and to ensure future energy demands are met to support economic activity.

Energy technology advancements that are critical to the NGFS modelled climate transition pathways include:

- **Carbon Capture, Utilization and Storage (CCUS):** CCUS refers to technologies that capture CO2 from the combustion of fossil fuel. Specific to the energy sector, these types of technologies are direct air capture, transport and storage (either in a compressed liquid form or in geological form). This technology is currently expensive to execute at scale, but is generally assumed to grow dramatically to facilitate any of the low physical risk (~1.5˚C) scenarios.
- **Biomass:** Traditional biomass sources include wood, animal waste and charcoal. While traditional biomass sources are widely available and often the first form of energy utilized in emerging economies, they are often less efficient from both a carbon emissions and energy perspective and can create adverse health impacts in many instances through the release of other pollutants. Modern bioenergy converts traditional biomass forms into advanced liquids and gases than can be produced and used more sustainably and for a wider array of purposes, including electricity generation and transportation fuel. This includes purpose-grown bioenergy crops, repurposing organic waste from the agricultural and forestry sectors and municipal solid waste.
- **Efficiency improvements:** Technology has become more efficient over time due to engineering advancements that reduce energy loss during the transportation, transmission, and refinement processes. This allows for the same amount of work to be done with less energy expenditure. This trend will need to continue at a rapid pace for decarbonization goals to be met.

Renewable technology advancements needed to achieve modelled transition pathways include:

- **Storage:** A key issue that is holding back the proliferation of renewable energy in the energy system is a lack of storage technology. Because renewables (particularly solar and wind) are intermittent energy sources, storage is necessary to provide the system with continuous energy even when the sun is not shining and the wind is not blowing. Without storage, the grid will require back up energy from non-volatile sources (liquid fossil or renewable fuels, biomass, or nuclear).
- **Non-subsidized/market competitive manufacturing for scalability:** Renewable technology must become cost competitive without subsidization from the government for it to expand at scale.

Behavioral (market) changes

Behavioral change is key to reducing emissions but is often overlooked. As mentioned earlier, a transition to a low carbon economy is a socio-economic transition that requires changes to the current way of life and the way we travel. A few examples of behavioral changes, as defined by the International Energy Agency, that are needed to help achieve net-zero targets include[8]:

- Replacing all flights that are less than one hour in travel time with high-speed rail where feasible
- Reducing the speed limit on major motorways to less than 62 mph
- Restricting space heating to 68° F and space cooling to 75° F
- Improving public mobility and access to reduce reliance on combustible engine cars
- Limiting the number of long-haul flights for leisure travel at 2019 levels, despite a growing population and increased global wealth

Turning research into action

The information provided in this paper can be leveraged by companies in different sectors to understand the climate challenge and conceptualize implications for their business. The suggested framework allows for companies to identify key drivers that can help build and monitor transition pathways. Bespoke suggestion on how companies can leverage the information is provided below:

What can energy sector companies do?
To prepare for the energy transition, it is imperative that the energy sector understands the current energy mix and potential implications for demand and supply of different energy sources in a low carbon economy. Energy companies should also proactively monitor policy and quasi-regulatory discussions related to energy at a global level to understand what expectations are being set. Even if discussed rules do not become law, they still influence investors which forces companies to adapt. As first steps, energy companies could start by leveraging these insights to discuss 'what if' scenarios as part of a broad climate transition discussion, which can then influence strategy.

What can non-energy sector companies do?
Every sector will be impacted in some way by the energy transition. Companies should conceptualize what the energy transition means for its business and evaluate risks and opportunities. They will need to consider what kinds of changes are needed at the business and product level to respond to the energy transition. These assessments can inform capital allocation and strategy decisions to support the transition. Companies should also monitor policy, technological and market changes in different regions to assess how transition risks may affect their business. Finally, they could adopt a circular economic approach to product design and lead through innovation.

Send questions or comments to
sustainability@libertymutual.com

[1] Enabling activities are activities that would not otherwise be considered sustainable, but contribute to the overall objective of promoting sustainability. Specifically, enabling activities are explicitly defined by the EU Green Taxonomy. Source: S&P Global

[2] Seeing through the smog: Towards a more robust measure of climate transition risk - Willis Towers Watson

[3] A Definition of Systems Thinking: A Systems Approach" - Arnold and Wade, 2015

[4] Network for Greening the Financial System Scenarios Portal

[5] 2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy." Environment and Climate Change Canada.

[6] Taskforce for Climate-related Financial Disclosures Guidance

[7] Primary energy is defined as energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary energy. Source: EIA

[8] International Energy Agency Net Zero 2050 Report

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